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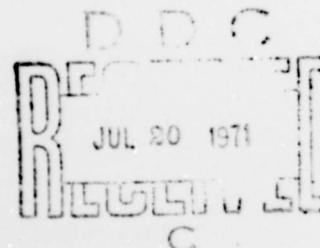
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Materiel Test Procedure 10-2-207
General Equipment Test Activity

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

RATIONS



1. OBJECTIVE:

This document provides test methodology and testing techniques to determine the technical performance and safety characteristics of complete rations including packaging and packing as described in Materiel Need (MN) and to determine the item suitability for service tests.

2. BACKGROUND

a. Feeding the Armed Forces of the United States is a world wide operation that must provide millions of meals each day under almost every conceivable condition. Since the operational capability of a fighting man can rise or fall depending upon his food intake, a great deal of attention is paid to the nutritional adequacy and palatability of his food. Army Regulation 40-5 outlines the basic nutritional requirements and sets the standard for nutritional content of military rations. Calories and nutritional adequacy, however, do not make a food palatable and, since food is an important morale factor, the development of experimental food items and their adaption to combat feeding situations is a continuing process.

b. Feeding of military personnel can be grouped into two broad categories. The first is feeding troops in garrison or similar situations where trained personnel and suitable equipment are available to prepare practically all of the types of foods used by the civilian population. The second category is feeding troops operating away from the garrison in situations ranging from the mere lack of refrigeration or similar facilities to where individuals or small groups are operating under stress conditions, such as combat.

c. The size of the operation magnifies problems of procurement, warehousing, and distribution. It is in the operational ration area that most of the armed services research and development effort on foods has been expended. For this usage, foods must be designed and packaged to withstand the extremes of climatic conditions found throughout the world; also, minimal weight and cube are important logistical factors.

*This MTP is intended to be used as a basic guide in preparing actual test plans for the subject material. Specific criteria and test procedures must be determined only after careful appraisal of pertinent MN, and any other applicable documents.

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d. Engineering tests performed on experimental rations involve the consideration of subjective and objective measurement techniques. The use of subjective measurement is applied to the determination of soldier attitudes towards the rations and components of rations, and measurement of food preference and acceptance.

e. More objective testing techniques, involving the use of instrumentation, etc., are used in determining such factors as food packaging durability, reliability, water resistance, dispersibility and portability, value analysis and safety characteristics of rations and their components. Additionally, and with the concurrence of the Surgeon General, these test methods are also used to determine the nutritive value and physiological effects of consumption of the food items developed.

3. REQUIRED EQUIPMENT

The following equipment, or suitable substitutes, will be required to accomplish the testing procedures as specified by this document.

Rations: a. Instrumentation Requirements for Evaluating Combat

- 1) X-Ray Inspection Units.
 - 2) Electronic Temperature Recorder (Multi-Channel, Thermocouples and Thermistors).
 - 3) Altitude Chamber.
 - 4) Universal Tester.
 - 5) Environmental Chambers (Temperature and Humidity).
- NOTE: These test instrumentation devices and equipment are described in the Appendices.

b. Scales, weighing, calibrated.

c. Stop Watches.

d. Field Stove(s), as applicable.

e. Photographic Equipment.

f. Administrative Materiel:

- 1) Data forms.
- 2) Food rating questionnaires.
- 3) Miscellaneous e.g., pencils, code marking pens, rulers/ yardsticks, knives, etc.

g. Tarpaulins.

h. Pallets (wood, standard item).

i. Room Partitions (dividers).

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- j. Testing Tables (with individual places partitioned off).
- k. Laboratory and/or bench testing facilities, as required.

4.

REFERENCES

- A. Army Regulation 40-5 Medical Services: Preventive Medicine, Appendix 5, Basic Dietary Standards for the U.S. Army.
- B. Army Regulation 70-38 Research and Development: Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
- C. Army Regulation 705-15 Research and Development of Materiel: Operation of Materiel Under Extreme Conditions of Environment.
- D. USATECOM Regulation 70-23 Research and Development: Equipment Performance Reports (EPRs).
- E. USATECOM Regulation 385-6 Safety: Verification of Safety of Materiel During Testing.
- F. USATECOM Regulation 700-1 Value Engineering.
- G. USATECOM Regulation 750-15 Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
- H. USAGETA Document Human Factors Evaluation Data for General Equipment (HEDGE).
- I. USAGETA Regulation 70-4 Research and Development: Human Factors and General Equipment Testing.
- J. USAGETA Regulation 705-4 Research and Development of Materiel: Instrumentation Services and Materials Analysis Services.
- K. FED-STD-101 Preservation, Packaging, and Packing Materials; Test Procedures.
- L. FED-STD-151 Metals: Test Methods.
- M. FED-STD-406 Plastics, Methods of Testing.
- N. MIL-STD-129 Marking for Shipment and Storage.
- O. MIL-STD-130 Identification Marking of US Military Property.
- P. MIL-STD-209 Slings, Eyes and Attachments for Lifting and Tying Down Military Equipment.
- Q. MIL-STD-810 Environmental Test Methods.
- R. MIL-STD-1186 Cushioning, Anchoring, Bracing, Blocking, and Waterproofing, and Appropriate Test Methods.
- S. MTP 7-2-509 Air Drop Capability of Materiel.
- T. MTP 8-2-509 Radiography.
- U. MTP 10-2-212 Preparation Method and Equipment, Food Service.
- V. MTP 10-2-500 Physical Characteristics.
- W. MTP 10-2-501 Operator Training and Familiarization.
- X. MTP 10-2-502 Durability.
- Y. MTP 10-2-503 Surface Transportability (General Supplies and Equipment).
- Z. MTP 10-2-505 Human Factors Engineering.

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- AA. MTP 10-2-507 Maintenance Evalaution
- AB. MTP 10-2-508 Safety
- AC. MTP 10-2-511 Quality Assurance
- AD. MTP 10-2-512 Reliability.
- AE. MTP 10-4-001 Desert Environmental Test of General Supplies and Equipment
- AF. MTP 10-4-003 Tropic Environmental Test of General Supplies and Equipment.
- AG. MTP 10-4-004 Arctic Environmental Test of Rations.
- AH. Cochran and Cox, Experimental Design, John Wiley and Son, 1950.
- AI. Churchman, C. West and Ratoosh, Philburn, Measurement, Definitions and Theories, John Wiley and Son, 1959.
- AJ. Methods of Analysis of the Association of Official Agricultural Chemists, Ninth Edition, 1960.

5. SCOPE

5.1 SUMMARY

This procedure describes the preparation for, and methods of, evaluating the technical performance and safety characteristics of complete rations. To assess the degree of conformance with required standards and established criteria the complete rations should be subjected to the following:

- a. Preparation for Test - A pretest inspection to determine the condition of the complete ration and its associated packaging, upon arrival at the test site. A determination of the complete ration physical characteristics, and an operator training and familiarization requirements.
- b. Food Preparation and Equipment Evaluation - An evaluation to examine specific ration design characteristics with regard to compatibility and suitability for use with prescribed preparation instructions and equipment.
- c. Environmental Tests - A series of tests designed to examine and measure changes in the performance and physical characteristics of ration components, packaging and packing when subjected to controlled changes in environmental parameters.
- d. Transportability - An evaluation to determine the ability of the ration in its shipping configuration to withstand the forces experienced during normal handling and transporting including air delivery capabilities.
- e. Durability - A test of the ability of the ration and packing to meet nutritional and performance requirements after specified periods of storage.

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f. Reliability - A mathematical evaluation to determine the probability at a given confidence level that the ration and packaging will meet specific performance requirements with respect to nutritional adequacy, storage stability, and palatability of foods and adequacy of packaging.

g. Safety - An evaluation to determine the safety characteristics and possible hazards associated with use of rations, foods, and packaging.

h. Human Factors - An evaluation to determine the adequacy of the design and performance requirements of the complete ration and its accessories in terms of conformance to accepted human factors engineering design criteria.

i. Value Analysis - An evaluation directed at analyzing the primary function of the complete ration for the purpose of cost reduction without compromising performance, reliability, quality, maintainability or safety.

j. Quality Assurance - A review for the purpose of determining and evaluating defects in material and workmanship.

6. PROCEDURES

6.1 PREPARATION FOR TEST

NOTE: Prepare an EPR in accordance with applicable procedures in USATECOM Regulation 70-23 for any items that are missing, damaged or considered inadequate when completing the following procedures:

6.1.1 Inspection

Upon receipt of the complete rations at the test site, perform the following:

a. Visually inspect the complete rations; record and photograph evidence of any damage incurred during transport.

b. Before offloading a shipment, inspect and evaluate methods of tiedown, blocking, bracing, waterproofing, etc. employed. Record any deviations from applicable Military Standards. (See c.1) below).

c. After the complete rations have been offloaded, remove all items from the shipping container, and as applicable.

- 1) Visually inspect the shipment: evaluate with regard to, and record any deviations from, the applicable portions of the following military standards:

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- a) MIL-STD-129 Marking for Shipment and Storage.
 - b) MIL-STD-130 Identification Marking of U.S. Military Property.
 - c) MIL-STD-1186 Cushioning, Anchoring, Bracing, Blocking and Waterproofing, and Appropriate Test Methods.
- 2) Record any damage or deterioration resulting from handling, improper packaging, and/or inadequate preservation.
 - 3) Observe and record the extent of depreservation required.
 - 4) Inspect the complete ration and record any evidence of defects in the following areas:
 - a) Workmanship/Construction/Materials: In general all ration packaging should be well made and free from defects. Methods of construction should indicate sound design and good work practice. Materials should be new and as authorized by the applicable component specifications.
 - b) Visual inspection shall concentrate on the following:
 - 1. Plastic shall be nearly molded and free from roughness, irregularities, foreign material or detrimental defects. The surface shall contain no porous areas or bubbles.
 - 2. Packaging and packing shall be in accordance with applicable specifications and adequate to ensure watertightness and strength. All seams shall be smooth, uniform, and free from faults, dirt, or other extraneous material.
 - 5) Record any observed defect or condition which is considered to be a potential hazard to the safety of test personnel or facilities.
 - 6) Photograph the complete rations, and packaging in the received condition.
 - 7) Suitability of the complete rations for testing.

6.1.2

Inventory Check

a. Conduct an inventory against Menu Component Lists. Note evidence of the following:

- 1) Shortages in rations and components.
 - 2) Damages.
 - 3) Missing accessory pockets
- b. Submit an EPR for each noted shortage or discrepancy.

6.1.3 Physical Characteristics

as follows: Perform the applicable procedures of MTP 10-2-500; note data

- a. Type of ration.
- b. Manufacturer.
- c. Date packed.
- d. Total weight of case.
- e. Total weight of individual ration.
- f. Total weight of each item within the individual ration.
- g. Dimensions of individual ration.
- h. Outside cubage measurement of case.
- i. Type of waterproofing, e.g., plastic covering, plastic spray, etc.
- j. Number of individual rations per case.

6.1.4 Operator Training and Familiarization

Members of the test team shall be oriented in accordance with MTP 10-2-501.

- a. Record the rank, MOS, past experience, and extent of additional training required for each test team member.
- b. Review test personnel in all safety precautions and hazards associated with test facilities and testing procedures.
- c. Instruct test personnel in the capabilities, operational characteristics, and limitations, in accordance with guidance contained in the draft technical manuals and other instructional material. Training, instruction, and familiarization shall include but not be limited to the following:
 - 1) Applicable terminology.
 - 2) Operation and use of test facilities.
 - 3) Furnish the team members information concerning the complete rations as follows:
 - a) Physical characteristics and description.
 - b) Limitations.

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d. Instruct test team members in test objectives and orientation of food rating techniques.

e. Instruct test team members through orientation, demonstration; and practice the proper utilization of available equipment for food preparation.

6.2 TEST CONDUCT

The testing program shall be arranged to determine by controlled, measured, and instrumented testing, the technical performance and safety characteristics of the complete rations.

NOTES: 1. All equipment malfunctions occurring during the testing procedures shall be reported in accordance with USATECOM Regulation 70-23.

2. Prior to initiating test procedures, the test officer will review and implement all safety considerations contained in Section 6.2.11.

6.2.1 Food Preparation and Equipment Evaluation

Thirty cases will be randomly selected for the following tests.

6.2.1.1 Conventional Meal

a. Food will be prepared by trained food service personnel using ranges and cooksets and usually will be served in unit messes. The new food processing techniques used to produce this type of meal will, however, reduce the amount and degree of training required for food service personnel.

NOTE: Food will be prepared properly, i.e., bacon will be fried, potatoes will be fried, boiled or mashed, meats will be fried or heated up, etc.

b. Maintain a record of the following for each type stove and type of ration tested:

- 1) Type of stove.
- 2) Type of ration.
- 3) Preparation procedure for each food component.
- 4) Adequacy of equipment:
 - a) Cooking utensils.
 - b) Heating apparatus.
- 5) Amount of water required to prepare:
 - a) Food.
 - b) Beverage.

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- 6) Adequacy of food preparation and heating method.
 - 7) Time required to:
 - a) Prepare stove for use (to include igniting).
 - b) Prepare food (to include beverage).
- NOTE: Timing will include opening rations, preparing stove, to food consumption.
- 8) Test officers' and observers' opinions on the ability of the soldier to prepare rations for consumption with little or no instructions.

c. Results of laboratory analysis of random sample of each menu.

d. Retain a copy of preparation instructions provided with each type of ration, if available.

6.2.1.2 Quick Serve Meal

a. Food will be prepared by untrained food service personnel, required equipment will consist solely of a means for heating water.

b. Prepare food for consumption by adding hot or cold water to the packages (as appropriate to the food), mixing, and holding for not more than 20 minutes.

c. Maintain a record of the following:

- 1) Type of ration.
- 2) Preparation procedure for each food component.
- 3) Adequacy of equipment for heating water.
- 4) Amount of water required, in ounces.
 - a) Food.
 - b) Beverage.
- 5) Temperature of water used to prepare food or beverage.
- 6) Adequacy of food preparation and heating method(s).
 - a) Food was not heated enough.
 - b) Food scorched.
 - c) Food not heated throughout.
- 7) Time required to:
 - a) Ignite heating apparatus.
 - b) Prepare food (to include beverage).
- 8) Ease of mixing powdered components with cold water.
- 9) Test officers' and observers' opinions on the ability of the soldier to prepare rations for consumption with little or no instructions.

d. Results of laboratory analysis of random sample of each menu.

e. Retain a copy of preparation instructions provided with each type of ration, if available.

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6.2.1.3 Accessory Packet

Components of the accessory packet (if furnished) shall be evaluated as follows:

- a. Matches will/will not ignite.
- b. Packaging sufficient to keep contents from becoming dry or brittle.
- c. Toilet paper.
 - 1) Quantity.
 - 2) Quality.
 - a) Strength of paper.
 - b) Size of individual sheets.
- d. Thermodent sticks.
 - 1) Too thin or brittle.
 - 2) Desirable/undesirable flavor.
 - 3) Adequate for cleaning teeth.

6.2.2 Palatability Tests

Determine whether the experimental rations, individual meals, and ration components are sufficiently palatable to ensure consumption, and whether the rations contain a maximum variety of components consistent with considerations of size, weight, nutritional requirements, and highest acceptability.

NOTE: The palatability of experimental rations is determined during field trials involving groups of soldiers. While some degree of control is required, the extent to which this can be accomplished is, of necessity, limited to prevailing tactical and environmental conditions. Controls which may be attained include:

- 1. Approximate equality in numbers of individual participants or troop units consuming both standard and experimental rations.
- 2. Representatives of the sample to include different types of combatant and noncombatant troops.
- 3. The use of both the standard and experimental rations by all participants within minimum and maximum times prescribed for consumption of the rations.

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a. Prepare and conduct an applicable field trial evaluation program(s) using Appendix A as a guide for rating.

b. Record the following:

- 1) Type of trial test conducted.
- 2) Number of participants, by type, i.e., 10 combatants and 5 noncombatants.
- 3) Individual palatability or acceptance ratings gathered through the use of rating scales or other similar food evaluation techniques.
- 4) Responses to individual interviews and group administered questionnaires relating to specific utility characteristics and overall suitability and acceptance of the experimental and control rations, meals, and components for use by the soldier.
- 5) Amount of food consumed.

6.2.3 Nutritional Evaluation

a. Basically, the determination of nutritional requirements of experimental rations is the responsibility of the Office of the Surgeon General. Final decisions regarding these factors will be made by the Office of the Surgeon General in conjunction with the agency responsible for development of the experimental rations. However, as part of the Engineering Test, data relevant to nutritional aspects shall be obtained as follows:

b. Determine whether the experimental rations conform to nutritional requirements as specified in Appendix 5, AR 40-5 by conducting the applicable sections outlined in Methods of Analysis of the Association of Official Agricultural Chemists.

NOTE: Nutritional Analyses of experimental rations procured for the engineering test may be accomplished by qualified personnel working under contract to the test agency.

6.2.4 Environmental Effects Evaluation

The purpose of these tests is to determine the ability of the complete rations and their various components and accessories to resist physical damage and/or deterioration when subjected to accelerated climatic and environmental conditions. Testing should be conducted as necessary to ensure that the complete ration performance requirements are satisfactory under conditions existing within the operating areas and/or environments as specified by the applicable MN and as defined by AR 70-38.

6.2.4.1 Tropic Environment Evaluation

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Accomplish the applicable procedures of MTP 10-4-003. Note the test data.

6.2.4.2 Desert Environment Evaluation

Accomplish the applicable procedures of MTP 10-4-001. Note the test data.

6.2.4.3 Arctic Environment Evaluation

Accomplish the applicable procedures of MTP 10-4-004. Note the test data.

6.2.4.4 Climatic Tests

Subject the complete rations to representative climatic conditions as defined by AR 70-38 and as specified by the applicable MN. Use the procedures and tests as outlined in paragraph 6.2.5 storage tests.

6.2.5 Storage Tests

Storage tests for experimental rations shall be conducted as follows to ascertain the effects of various storage conditions on ration components.

6.2.5.1 Storage Under Normal Warehouse Conditions (No Refrigeration)

NOTE: Normal warehouse conditions shall consist of a dry storage area with a temperature ranging from 55°F. to 75° F.

a. Visually examine and x-ray rations for observable defects prior to start of test. Record deficiencies by type and location.

NOTE: Appendix B describes types of X-ray inspection units.

b. Place a minimum of 100 cases of rations in storage, under normal conditions, for a minimum of 2 years.

c. Every 15 days, from the starting date, remove one case of rations and perform the following:

- 1) For each case of rations, determine and record the nutritional evaluation, as described in Appendix 5 AR 40-5, at the end of each storage period.
- 2) Visually examine and x-ray each case for defects. Record all deficiencies by type and location, and retain X-rays showing defects.
- 3) Record the period of storage.

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NOTE: All remaining cases of rations shall be subjected to the same procedures at end of the 2 years.

- d. Note total number of rations (cases evaluated.
- e. Note the temperature and humidity of warehouse.

6.2.5.2 Storage under Adverse Exposure Conditions

Determine the ability of experimental rations to withstand storage under adverse exposure conditions as follows:

6.2.5.2.1 Cache Storage - A simulated cache storage situation shall be conducted as follows:

a. Visually examine and x-ray rations for observable defects prior to test. Record deficiencies by type and location.

b. Store 6 cases of rations in the ground (sandy loam), covered with 6 inches of dirt, for 6 weeks.

c. Every week remove one case and repeat step c. of paragraph 6.2.5.1

d. Repeat steps a through c in sand.

e. Repeat steps a through c in mud.

6.2.5.2.2 Water Exposure - Simulate storage of rations exposed to water as follows:

a. Prepare a water exposure test chamber.

NOTE: The chamber shall be suitable for supplying water at the rates specified herein.

b. Visually examine and x-ray rations for observable defects prior to start of test. Record deficiencies by type and location.

c. Subject a minimum of 3 cases of rations to torrential downpour conditions, as described in Appendix C, 1. for a period of 3 days.

d. Examine the packaging of the rations every two hours for signs of deterioration.

e. Upon completion of the exposure, visually examine and x-ray the rations.

f. Note the following for each examination:

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- 1) Number of rations
- 2) Amount of water damage (deterioration) to:
 - a) Case packaging
 - b) Individual ration packaging
 - c) Accessory packaging
 - d) Food packaging.

NOTE: Record as heavy, moderate, slight or showing no evidence.

- 3) Defects observed through X-rays.
- 4) Adequacy and type of waterproofing of:
 - a) Case.
 - b) Individual ration.
 - c) Accessory pack(s).
 - d) Food components.

NOTE: Sample comments - "Water soaked through waxed seal of case, however, the plastic covering of the individual rations prevented water damage - all waterproofing failed (waxed seal leaked and plastic covering was not sealed completely) and all accessories were heavily damaged and cans began to rust.

g. Retain X-rays showing observable defects.

h. Repeat steps b. through g. under moderate rainfall conditions.

i. Repeat steps b. through g. under drizzling rainfall conditions.

j. Repeat steps b. through i. by subjecting 3 individual rations to the tests without the protection of the case covering.

6.2.5.2.3 Altitude Exposure - Determine the ability of the test ration to meet air transit conditions prescribed in paragraph 7.1D, Change 1, AR 705-15 as follows:

a. Prepare an altitude chamber as described in Appendix C, 2. which can simulate various altitudes of military and civilian aircraft.

b. Visually examine individual experimental rations for observable defects prior to start of test. Record deficiencies by type and locations.

c. Subject a minimum of 3 individual experimental rations to simulated air pressure at a 40,000-foot altitude (5-inches of mercury or 2.47 pounds p.s.i.).

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d. Upon completion of exposure, examine the rations and record the following:

- 1) Visual defects observed by type and location.
- 2) Items which failed to hold-up under the 2.47 lbs. p.s.i., i.e., cans exploded, vacuum seals failed, etc.

6.2.5.2.4 Temperature Exposure - Simulate storage of rations exposed to temperatures as follows:

a. Prepare an environmental chamber as described in Appendix C, 3, or 4.

b. Visually examine and x-ray rations for observable defects prior to start of test. Record deficiencies by type and location.

c. Subject a minimum of 2 individual experimental rations to -65°F for a period of 6 weeks.

d. Remove rations from chamber and:

- 1) Visually examine and x-ray rations for observable defects.
- 2) Thaw the rations and repeat paragraph 6.2.3.
- 3) Examine food for physiological effects due to extreme temperatures, i.e., chocolate becomes discolored, powdered coffee/tea becomes pasty, etc.

e. Note the following:

- 1) Packaging defects.
- 2) Items which failed to hold-up when frozen, i.e., vacuum seals failed, cans expanded causing change in their dimensions, metal cans and plastic containers cracked, etc.
- 3) Nutritional data collected as outlined in Methods of Analysis of the Association of Official Agricultural Chemists.
- 4) Physiological effects due to changes in the physical appearance of the test ration.

f. Retain X-rays showing defects.

g. Repeat steps b. through f., as applicable, at a temperature of 100° F. with humidity of 100 percent for 6 months.

h. Repeat steps b. through f., as applicable, for repeated freezing and thawing with ambient temperatures of -50°F. and +114°F. alternated on a 12-hour cycle for a total of 40 freezing and thawing cycles. Withdrawals to be made after 1/2, 1, 2, 3, 4, 7, 10, 15, 25 and 40 days of storage. Inspect cases and components for any evidence of failures.

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6.2.5.2.5 Salt Spray (Fog) Exposure - Simulate storage of rations exposed to salt spray (fog) as follows:

a. Prepare a salt spray (fog) chamber as described in Appendix C, 5.a.

b. Visually examine and x-ray rations for observable defects prior to start of test. Record deficiencies by type and location.

c. Subject a minimum of 2 cases of rations to salt spray (fog) solution, as described in Appendix C, 5. b. for a period of 10 days.

d. Examine the rations and record the condition of the packaging.

e. After salt spraying exposure, leave the rations stored in the chamber for 3 weeks with temperature at 80° F. and humidity of 5 percent.

f. Remove rations, examine the packaging, and repeat paragraph 6.2.3.

g. Note the following after 3 week storage period:

- 1) All packaging defects.
- 2) Nutritional data collected as outlined in Methods of Analysis of the Association of Official Agricultural Chemists.

6.2.5.2.6 Insect and Rodent Resistance

a. Place a minimum of 50 cases of rations in storage for a period of 3 months in a hot-wet environment.

b. Storage conditions.

- 1) Individual cases stacked on pallets covered with a tarpaulin.
- 2) Individual cases stacked on pallets without any covering.

c. Maintain record of the following:

- 1) Weather summary during storage period.
- 2) Evidence of damage to cases or rations by gnawing animals.
- 3) Evidence of insect infestation of cases or rations.
- 4) Adequacy of packaging material and design.

6.2.6 Chemical, Biological, and Radiological Tests

a. Determine the effects of chemical, biological, and radiological agents on complete rations as described in the applicable sections of MTP 8-2-035 and MTP 8-2-509.

b. Determine the following:

- 1) Adequacy of packing case to withstand and provide CBR protection.
- 2) Results of laboratory analysis of random sampling of rations from cartons.
- 3) Adequacy of individual food container to provide CBR protection.

6.2.7 Transportability

NOTE: Personnel should be familiar with the applicable portions of:

1. MIL-STD-129 Marking for Shipment and Storage.
2. MIL-STD-209 Slinging Eyes and Attachments for Lifting and Tying Down Military Equipment.

a. Appropriate literature shall be reviewed or consulted for proper procedures for tying down, lifting, and transporting pre-packed palletized rations by various media. Any inadequacy of instructions should be reported by EPR.

b. Evaluate the transportability characteristics of the test item by accomplishing the applicable procedures of MTP 10-2-503. Note the test data.

6.2.8 Air Drop Capability Test

a. Air drop capability shall be determined as described in the applicable sections of MTP 7-2-509.

b. The test item will be rigged for air drop using standard aerial delivery techniques prescribed in TM 10-500 and TM 10-500-12 and air dropped as shown in Table I.

c. Maintain a record of the following:

- 1) Airspeed of each aircraft.
- 2) Wind velocity.
- 3) Altitude of each drop.

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- 4) Weight and cube of test item.
- 5) With or without parachute.
- 6) Any damage or failure of packaging or components.
- 7) Adequacy/inadequacy of air drop technique.

Table I. Aerial Delivery Methods

Type of Delivery	Rigging	Type of Aircraft
Low velocity (with parachute)	Standard 8-foot modular airdrop platform	C-130
Low velocity (with parachute)	A-22 aerial delivery container	CV-2
Low Velocity (with parachute)	A-21 aerial delivery container as a door bundle	C-130
Freedrop (without parachute)	One layer of standard energy dissipator around test item	C-130 CV-2
Freedrop (without parachute)	Without energy dissipator around test item	C-130 CV-2

6.2.9 Durability

Determine whether complete rations can withstand stringent combat and extreme environmental conditions without detrimental effects to the foods and packaging by performing the applicable procedures of MTP 10-2-502.

a. Examine and evaluate the durability characteristics of available cases of complete rations that have undergone all of the foregoing tests. Note condition of the --

- 1) Case.
- 2) Individual component packaging.
- 3) Contents of the accessory package.
- 4) Food items (appearance).

b. Note test results.

6.2.10 Reliability

Evaluate the reliability characteristics of the test item by accomplishing the applicable procedures of MTP 10-2-512. Note the test data.

6.2.11

Safety

Evaluate the safety characteristics and features of the test item in accordance with the applicable procedures in MTP 10-2-508.

- NOTES:
1. Provide a safety recommendation in accordance with USATECOM Regulation 385-6, and the test directive, as applicable.
 2. During the conduct of all tests, test personnel shall observe the proper safety precautions and, in particular, shall adhere closely to the draft technical manual for the handling and use of the test item.
 3. The procedures for all tests shall be examined, and any condition which might constitute a safety hazard shall be recorded and reported.

Perform the following:

a. Examine the safety characteristics of the complete ration, including the procedures for its preparation, use and design to ensure that maximum safety has been provided consistent with military requirements. Hazards shall be classified as safe, marginal, critical, and catastrophic. Consider the following:

- 1) Examine for packaging that would subject the user to any safety hazards.
- 2) Examine rations to determine the food components are safe for human consumption as per AR 40-5 Section III PP 5-8-b.
- 3) Examine operating procedures in the light that improperly executed or misinterpreted instructions could result in bodily harm or equipment damage.

b. Test personnel shall record any worthwhile comments or suggestions relative to improvement of safety measures, and/or precautions.

c. Record number of foods rejected by menu, and reasons therefor.

6.2.1.2

Human Factors Evaluation

Accomplish the applicable procedures of MTP 10-2-505 and the following general evaluation:

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a. The complete ration shall be evaluated to determine the degree to which its physical design and revealed performance characteristics conform to recognized human factors engineering design criteria. Use the applicable requirements of Human Factors Evaluation Data for General Equipment (HEDGE), for Class IV B consumables. Prepare checklists to evaluate the human factors characteristics to be considered during conduct of the denoted tests.

b. In some instances the HEDGE test functions and subtests may be under consideration during the conduct of other tests. Where this condition exists the HEDGE requirements will be integrated into and conducted simultaneously with the corresponding tests.

c. General considerations to be included in checklists for all tasks:

- 1) Adequacy of instructions to perform the task.
- 2) Mental and physical effort required.
- 3) Design of the test item as it affects the task.
- 4) Time required to perform the task.

d. Specific considerations to be included for the HEDGE test functions, rate each task from a human factors standpoint.

- 1) Labels waterproof for field use items.
- 2) Spoilage indications clearly described.
- 3) Allowance for operator to perform required functions when wearing gloves, mitts, etc.
- 4) Do tabs, grasping or starting points for opening container contrast with package, or are they clearly identified?
- 5) Provisions for handling the item safely when in contact with flame or extreme heat.
- 6) Minimum number of measuring devices required to perform task.
- 7) Special opening tools avoided.

e. Perform the following tasks for the HEDGE test functions given and rate the task from a human factors standpoint. The considerations shall include, but not be limited to, the following:

- 1) Operability.
 - a) Unpackage.
 - b) Prepare.
 - c) Consume.
- 2) Transportability.
 - a) Prepare for transport by placing in a transit configuration.
 - b) Load/unload.
 1. Lift into/out of carrier.
 2. Secure/unfasten (to carrier).

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6.2.13 Value Analysis

a. During the conduct of all tests, test personnel shall evaluate the test item from a value versus cost standpoint. Record all pertinent comments concerning features or components which can be eliminated or modified to accomplish cost reduction without impairment of performance, reliability, quality, maintainability, or safety. The applicable portions of USATECOM Regulation 700-1 shall be used for this evaluation.

b. During handling, preparation, and consumption of the ration, observations shall be made for features which could be eliminated without compromising its nutritional value, physiological effects, reliability, durability, or safety.

c. Question test team personnel and users for features of the test item that may be eliminated without decreasing the functional value of the test item.

d. Note the following:

- 1) Nonfunctional features.
- 2) Costly features.
- 3) Nice-to-have features.
- 4) Comments of test team personnel and users.

6.2.14 Quality Assurance

Throughout all tests, examine the test item for compliance with the quality requirements of the applicable MN and the provisions of MTP 10-2-511.

6.3 TEST DATA

NOTE: In compiling the Test Data section, test personnel should expound upon those data procedures which are other than quantitative in nature by recording narrative descriptions which will provide full details of conditions and/or events occurring during the conduct of the test.

6.3.1 Preparation for Test

6.3.1.1 Inspection

Record the following:

- a. Manufacturer, nomenclature, and other appropriate data.

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- b. Method of transport used to deliver the complete rations.
- c. Any damage to the complete rations.
- d. Any damage or deterioration resulting from handling, improper packaging, and/or inadequate preservation.
- e. Any noncompliance with the standards for shipping, marking, preservation, and packaging.
- f. The extent of depreservation required.
- g. Any indication of defects in the following areas (describe in detail):
 - 1) Workmanship.
 - 2) Construction.
 - 3) Materials.
- h. Any condition considered to be a potential hazard to the safety of test personnel or facilities.
- i. Equipment, time, and personnel required to unpack the complete rations and comments concerning the method and materials used in packing.

j. Suitability of the complete rations for testing.

6.3.1.2 Inventory Check

List any materials missing from the Basic Issue Item List.

6.3.1.3 Physical Characteristics

Record the data required by MTP 10-2-500 and as follows:

- a. Type of ration.
- b. Manufacturer.
- c. Date packed.
- d. Total weight of case.
- e. Total weight of individual ration.
- f. Total weight of each item within the individual ration.
- g. Dimensions of individual ration.

- h. Outside cubage measurement of case.
 - i. Type of water proofing, e.g., plastic covering, plastic spray, etc.
 - j. Number of individual rations per case.
- 6.3.1.4 Operator Training and Familiarization
- Record the data required by MTP 10-2-501 and the following:
- a. Methods used and completion of test personnel training and evaluation of technical manuals.
 - b. Evidence that test personnel are sufficiently knowledgeable in objectives and procedures.
 - c. The personal data required for selected personnel.
- 6.3.2 Test Conduct
- 6.3.2.1 Food Preparation and Equipment Evaluation
- Record the quantitative adequacy, acceptability, and overall suitability of the menus, components, and packaging for use by the Army.
- 6.3.2.1.1 Conventional Meal
- Record the following for each type of stove and ration tested:
- a. Type of stove.
 - b. Type of ration.
 - c. Preparation procedure for each food component.
 - d. Adequacy of equipment:
 - 1) Cooking utensils.
 - 2) Heating apparatus.
 - e. Amount of water required, in ounces, to prepare:
 - 1) Food.
 - 2) Beverage.
 - f. Time required to:
 - 1) Prepare and ignite stove, in minutes.
 - 2) Prepare food, in minutes.

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g. Adequacy of food preparation and heating method.

h. Test officer's and observer's opinions on the ability of the soldier to prepare rations for consumption with little or no instructions.

6.3.2.1.2

Quick Serve Meal

Record the following:

a. Type of ration.

b. Preparation procedure for each food component.

c. Adequacy of equipment for heating water.

d. Amount of water required, in ounces.

1) Food.

2) Beverage.

e. Temperature of water used to prepare food or beverage.

f. Adequacy of food preparation and heating method(s).

1) Food was not heated enough.

2) Food scorched.

3) Food not heated throughout.

g. Time required to:

1) Ignite heating apparatus.

2) Prepare food (to include beverage).

h. Ease of mixing powdered components with cold water.

i. Test officer's and observer's opinions on the ability of the soldier to prepare rations for consumption with little or no instructions.

j. Results of laboratory analysis of random sample of each menu.

k. Retain a copy of preparation instructions provided with each type of ration, if available.

6.3.2.1.3

Accessory Packet -

Record the following:

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- a. Matches will/will not ignite.
- b. Packaging sufficient to keep contents from becoming dry or brittle.
- c. Toilet paper.
 - 1) Quantity
 - 2) Quality.
 - a) Strength of paper.
 - b) Size of individual sheets.
- d. Thermodent sticks.
 - 1) Too thin or brittle.
 - 2) Desirable/undesirable flavor.
 - 3) Adequate for cleaning teeth.

6.3.2.2 Palatability Tests

Record the following:

- a. Type of trial test conducted.
- b. Number of participants, by type, i.e., 10 combatants and 5 non-combatants.
- c. Individual palatability or acceptance ratings gathered through the use of rating scales or other similar food evaluation techniques.
- d. Responses to individual interviews and group administered questionnaires relating to specific utility characteristics and overall suitability and acceptance of the experimental and control rations, meals, and components for use by the soldier.
- e. Amount of food consumed.

6.3.2.3 Nutritional Evaluation

Data shall be collected and recorded as described in AR 40-5, Appendix 5, and applicable sections of Methods of Analysis of the Association of Official Agricultural Chemists.

6.3.2.4 Environmental Effects Evaluation

6.3.2.4.1 Tropic Environment Evaluation -

Record data as required by MTP 10-4-003.

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6.3.2.4.2 Desert Environment Evaluation -

Record data as required by MTP 10-4-001.

6.3.2.4.3 Arctic Environment Evaluation -

Record data as required by MTP 10-4-004.

6.3.2.4.4 Climatic Tests -

Record data as required by tests in paragraph 6.3.2.5.

6.3.2.5 Storage Tests

6.3.2.5.1 Storage Under Normal Warehouse Conditions (No Refrigeration) -

a. Record the following:

- 1) Results of pretest visual examination and X-rays by:
 - a) Type.
 - b) Location.
- 2) Number of rations stored.
- 3) For each case of rations:
 - a) Period of storage (15 days, 45 days, 180 days, etc.)
 - b) Results of visual examination and X-rays by:
 1. Type.
 2. Location.
 - c) Data as collected and recorded, pertaining to nutritional evaluation, as described in Appendix 5, AR 40-5.
- 4) Temperature and humidity of warehouse, in degrees F. and percent at the end of each 15 day period.

b. Retain X-rays showing defects.

6.3.2.5.2 Storage Under Adverse Exposure Conditions -

6.3.2.5.2.1 Cache Storage --

a. Record the following for each storage condition:

- 1) Results of pretest visual examination and X-rays by:
 - a) Type.
 - b) Location.
- 2) Storage condition (mud, sand, etc.).
- 3) For each case of rations:
 - a) Length of storage, in days.
 - b) Results of visual examination and X-rays by:
 1. Type.
 2. Location.

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- c) Data as collected and recorded, pertaining to nutritional evaluation, as described in Appendix 5, AR 40-5.

b. Retain X-rays showing defects.

6.3.2.5.2.2 Water Exposure --

a. Record the following for each type of exposure:

- 1) Type of exposure (downpour, drizzle and moderate rainfall).
- 2) Number of rations.
- 3) Results of pretest visual examination and X-rays by:
 - a) Type.
 - b) Location.
- 4) For each examination after exposure:
 - a) Amount of water damage (deterioration) to:
 - 1. Case packaging.
 - 2. Individual ration packaging.
 - 3. Accessory packaging.
 - 4. Food packaging.
 - b) Defects observed through X-rays.
 - c) Adequacy and type of waterproofing of:
 - 1. Case.
 - 2. Individual ration.
 - 3. Accessory pack(s).
 - 4. Food components.

b. Retain X-rays showing defects.

6.3.2.5.2.3 Altitude Exposure --

Record the following:

a. Results of pretest visual examination by:

- 1) Type.
- 2) Location.

b. Results of visual examination after altitude exposure by:

- 1) Type.
- 2) Location.

c. Items which failed to hold up under 2.47 pounds p.s.i.

6.3.2.5.2.4 Temperature Exposure --

a. Record the following:

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- 1) Results of pretest visual examination and X-rays by:
 - a) Type.
 - b) Locations.
- 2) For each test temperature:
 - a) Temperature, in °F.
 - b) Period of exposure.
 - c) Results of post-exposure visual examination and X-rays by:
 1. Type.
 2. Location.
 - d) Packaging defects.
 - e) Items which failed to hold up when frozen.
 - f) Nutritional data collected as outlined in Methods of Analysis of the Association of Official Agricultural Chemists.
 - g) Physiological effects.

b. Retain X-ray showing defects.

c. Any evidence of failure of rations during freezing and thawing cycle.

6.3.2.5.2.5 Salt Spray (Fog) Exposure --

a. Record the following:

- 1) Results of pretest visual examination and X-rays by:
 - a) Type.
 - b) Location.
- 2) Condition of rations packaging immediately after exposure to salt spray.
- 3) Results after 3 weeks of storage:
 - a) All packaging defects.
 - b) Nutritional data collected as outlined in Methods of Analysis of the Association of Official Agricultural Chemists.

b. Retain X-rays showing defects.

6.3.2.5.2.6 Insect and Rodent Resistance --

- a. Weather summary during storage period.
- b. Evidence of damage to cases or rations by gnawing animals.
- c. Evidence of insect infestation of cases or rations.
- d. Adequacy of packaging material and design.

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6.3.2.6 Chemical, Biological and Radiological Tests

Data shall be collected and recorded as described in applicable section of MTP 8-2-509.

6.3.2.7 Transportability

Record data as required by MTP 10-2-503 and as follows:

- a. Item under test (indicate manufacturer, model, etc.)
- b. Packaging or preparation methods used.
- c. Dimensions in transport configuration.
- d. Weight in transport configuration.
- e. Time required to accomplish preparations for shipment.
- f. MHE used.
- g. Method of transport utilized.
- h. Any evidence of shifting of contents, loosening or breaking of holddowns, ties, stays, blocking, or bracing.

6.3.2.8 Air Drop Capability Test

Record data as required by MTP 7-2-509 and as follows:

- a. Airspeed of each aircraft.
- b. Wind velocity.
- c. Altitude of each drop.
- d. Weight and cube of test item.
- e. With or without parachute.
- f. Any damage or failure of packaging or components.
- g. Adequacy/inadequacy of air drop technique.

6.3.2.9 Durability

Record data as required by MTP 10-2-502 and the following:

6.3.2.9.1 Accelerated Laboratory Wear Tests -

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6.3.2.9.1.1 Universal Tests --

Record the following for each case of rations tested:

a. Results of pretest visual examination and X-rays by:

- 1) Type.
- 2) Location.

b. Data collected and recorded as described in applicable sections of MTP 10-2-500.

c. Retain X-rays showing defects.

6.3.2.9.1.2 Tumbling Tests --

a. Record the following for each test and examination conducted:

- 1) Tumbling time (30, 60, 90, etc. minutes).
- 2) Type of damage.
- 3) Location of damage.

b. Retain photographs.

6.3.2.9.2 Overall Examination -

Record result of evaluations at completion of all testing to include the condition of:

- a. Case.
- b. Individual component packaging.
- c. Contents of accessory packaging.
- d. Food items (appearance).

6.3.2.10 Reliability

Record data as required by the applicable portion of MTP 10-2-512 and as follows:

- a. Total number of rations subject to physical abuse.
- b. Number of test items which suffered physical abuse.
- c. Total number of rations subject to storage.
- d. Number of test items which suffered:

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- 1) Physical deterioration.
- 2) Nutritional deterioration.

6.3.2.11 Safety

Record appropriate data as required by MTP 10-2-508 and as follows:

- a. Prepare a list of warning labels, instructions, and markings. Record the location and adequacy of each item listed.
- b. List any condition that might present a safety hazard including the cause of the hazard, and the steps taken to alleviate the condition.
- c. List any suggestions relative to improvement of safety features, safety measures and/or precautions.
- d. Provide a safety recommendation in accordance with USATECOM Regulation 385-6.

6.3.2.12 Human Factors Evaluation

Record the data required by MTP 10-2-505.

Prepare checklists for each of the various tasks associated with each test function. Rate each task as satisfactory or unsatisfactory from a human factors standpoint. In rating the task, include the specific considerations peculiar to the task and the following general considerations:

- a. Adequacy of instructions to perform the task.
- b. Mental and physical effort required.
- c. Design of the test item as it affects the task.
- d. Time required to perform the task.

6.3.2.13 Value Analysis

- a. Record comments for each of the topics listed below:
 - 1) Nonfunctional features.
 - 2) Costly features.
 - 3) Nice-to-have features.
 - 4) Comments of test team personnel and users.
- b. When making recommendations for changes in the test item features or components, record the following:

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- 1) The feature or component under consideration.
- 2) Recommended change(s).
- 3) Reason(s) for recommended change(s).

6.3.2.14 Quality Assurance

Record:

- a. Data required by MTP 10-2-511.
- b. Comments as to any design shortcomings in the area of required quality.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Data Reduction

Organize, analyze and summarize all raw data as specified in each of the MTPs referred to in paragraph 6.2. Use tabulations and charts as appropriate. Make a succinct, unbiased, and independent analysis of test data to show:

- a. The degree to which the test item meets stated requirements (test criteria) in MN or other approved documents.
- b. Deficiencies, shortcomings and suggested improvements.

6.4.2 Data Presentation

Evaluate and present a complete data summary indicating the results and address the following:

- a. Item characteristics such as performance, reliability, durability and human factors engineering.
- b. Comparison of test item characteristics with those of a similar item or standard (control item). Show whether the test item offers a significant improvement (or not) over the control item or only a minimal and perhaps costly improvement.
- c. Safety characteristics and safety recommendation. All aspects of safety must be evaluated to determine if a safety recommendation can be given or must be withheld pending correction of any hazards found.
- d. Conclusions and recommendations on overall test objectives and the suitability of the test item for service testing.

APPENDIX A

PALATABILITY TEST RATING TECHNIQUES

Most tests of specific foods, included as part of the evaluation of a complete ration or feeding system, are classified as acceptance tests. The most common acceptance involves a comparison of several items. Implicit in the acceptance test is the idea of ranking, the ultimate goal being to select the most acceptable of several item. Interest lies primarily in whether two or more items differ, and the magnitude of that difference in terms of a suitable criterion measure, such as a rating scale.

A common measurement technique used in a food acceptance test is the rating scale. Rating scales may vary, depending upon the purpose for which they are to be employed. However, the one most frequently used in U.S. Army ration testing is the Army 9-point hedonic scale. This consists of nine categories or adjectival phases ranging from "Like Extremely" to "dislike Extremely". It is a subjective device for obtaining the reaction or attitudes of soldiers to experimental and standard foods.

Another measurement process used is food consumption or rejection. This may be either subjectively or objectively determined. Subjective measures are usually based on estimates of food consumption made by test observer/recorders or by participants in a test. They may be expressed as the proportion or percentage of each food consumed in relation to the total amount served to each individual. An objective measure of consumption is usually obtained by weighing individual foods prior to serving, again after serving, and establishing the difference between these two weights. This technique is, of course, the most preferred; however, its use in many tests of experimental rations is not practical due to lack of control in the field.

In addition to rating scales and food consumption measurement, the personal interview may often be used in connection with acceptance tests of experimental rations. This technique is used when detailed information is to be obtained. The personal interview seldom will be administered to large groups of soldiers. When it is desirable to obtain data upon which predictions or interferences will be made to a larger group, or soldier population, a process of random sampling will be used to select a balanced or representative sample to which the interview will be administered.

Acceptance tests of individual food items are characterized by a high degree of control. Such control is necessary to attain the degree of precision and freedom from bias requisite to a determination of the desired measurement. Necessary control is built into a test through use of a suitable experimental design. In selecting a design, it is necessary to identify the different types of variation which may influence the test. Generally, this may be stated in terms of variation due to actual differences

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between the test items, and the variation due to extraneous factors such as time of day, weather, differences between individuals, groups, etc. By identifying and controlling for the different types of variation, it is then possible to isolate that part of the total variation which is due to differences between the test items.

Experimental designs for acceptance tests of experimental rations vary considerably in type and complexity.

The design used in any one instance must be suited to the specific requirements of that test. For example, if a test is concerned with only two foods, the experimental design is relatively simple compared to one used to measure differences in acceptance for the same two foods, when they have been subjected to storage for two periods of time, and each food is to be prepared by two different methods. In the straight acceptance test of two foods, there is one variable primary interest, namely, the simple difference in acceptance for items A and B in terms of the criterion used. While acceptance is still the basic variable in the second test, it is determined on the basis of differences between items A and B with respect to methods of preparation and storage periods. In terms of design requirements, the task is no longer a simple choice between two food items.

The designs described above are but a sample of many which may be used. In that specific designs are many and varied, it would be impractical to attempt development of specific illustrations or model solutions which could be considered all inclusive of those used in food acceptance testing. A knowledge on the part of the experimenter of the principles of experimental design and analysis are necessary to the proper accomplishment of this type of testing.

As directed by the experimental design, various necessary controls are implemented. For the controlled acceptance test, this is accomplished by randomly seating individuals as they enter a dining area to avoid systematic grouping which might bias the results obtained.

APPENDIX B

X-RAY INSPECTION UNITS

1. Portable X-Ray Inspection Unit

A portable X-Ray Inspection Unit is used primarily to flouroscope and radiograph all types of ration components prior to, during, and on completion of testing. Test items are first flouroscooped and if any deficiencies or defects are noted, a radiograph may be made for permanent record.

In addition to food components and packages, the Unit is capable of flouroscoping and radiographing other small test items that will fit its 14- by 17-inch opening. The upper 80 KVP limits allow radiography of plastics and thin metals. This type of X-Ray Unit is classified "A" (totally protective) by the Environmental Health Laboratory of the Army Medical Service. Therefore, personnel monitoring is not required. Limits: 45 to 80 KVP, 2 to 5MA.

2. Mobile Radiographic and Fluroscopic Unit

The Mobile Radiographic and Fluoroscopic Unit is housed in a modified van. It was originally designed for the examination of subsistence test items. A special small focal spot X-Ray tube may be mounted to enlarge test items radiographically, or, an oil-cooled industrial type X-Ray tube may be installed.

There are approximately 150 cubic feet of front and rear compartment space which can be allocated to the storage of test ration shipping cases, and instruments. Articles up to 24- by 24-inches may be inspected. With slight modifications, test items of any length may be examined. This particular unit requires a water source and drainage facilities. Personnel monitoring for X-Ray exposure is required.

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APPENDIX C

ENVIRONMENTAL TEST FACILITIES AND EQUIPMENT

1. Rain Course

The Rain Course is designed to simulate natural rainfall, which the soldier would encounter in the performance of his field duties, for testing the adequacy of foul weather garments, tentage, and all types of general military materiel including ration shipping containers and contents.

Man-made rain, anything from a slight drizzle to a torrential downpour, can be produced here with no more effort than a twist of the tap. High-pressure showerheads projecting from parapets thirty feet high produce simulated rainfall of varying intensities from one-tenth of an inch to three inches per hour. The Rain Course covers an area of 86 feet by 50 feet.

2. Altitude Chamber

This Altitude Chamber is designed for testing system components and small assemblies. It utilizes all-Lucite construction to permit visual observation of such effects as arc-over and corona. The technical specifications of the Chamber are: Altitude range (in feet) 0 to 200,000; 18 or 24 inch cube working area; pull-up time (minutes) to 10,000 feet, 15; 150,000 feet, 20; 200,000 feet, 30. The Chamber has six electrical feed throughs; ambient temperature ranges, room ambient temperatures must be held under 120 degrees Fahrenheit.

3. Small Environmental Chamber

This small Environmental Chamber is equipped with port arms for use in manipulating test items within its chamber. The chamber is designed for use in evaluating properties of food products, paper, paper products, and plastics used in food packaging, metals and fabric samples. It can be programmed for continuous or intermediate operation. Its upper and lower limits are from 0 to 200 degrees Fahrenheit, 20 to 100 percent humidity. The dimensions of this small Environmental Chamber are: 4 feet by 4 feet by 2 feet deep front to rear.

4. Large Environmental Chamber

This large Environmental Chamber is designed to operate in ambient temperatures from plus 20 degrees Fahrenheit to plus 95 degrees Fahrenheit. It has an interior capacity of 560 cubic feet of unobstructed, usable space; the cabinet is prefabricated in sections, so that any section can pass through any size opening and be assembled on the Chamber site desired.

The temperature range of the Chamber is adjustable from minus 80 degrees to plus 160 degrees Fahrenheit. Humidity range is from 20 percent to 100 percent relative humidity over a temperature range of plus 35 degrees to plus 160 degrees Fahrenheit. Control tolerance is plus or minus 2

percent relative humidity deviation from a set point of the control instrument. Temperature and humidity are automatically controlled and recorded with provisions for programming varying temperature and humidity conditions.

5. Salt Spray (Fog) Chamber and Salt Solution

a. Chamber

The salt spray chamber and accessories shall be constructed of materials which do not react with and are not affected by the corrosiveness of the salt spray (fog) and do not react with or affect the test specimens. The chamber shall be of adequate size with respect to the amount and size of items being tested. The top of the chamber shall be inclined to prevent dripping of condensed liquid upon the specimens. The door opening must be capable of being sealed to prevent loss of fog. A drain shall be provided at the low point to remove condensed salt fog and also prevent its return to the salt solution reservoir. A vent should be located in the wall of the chamber as far from the atomizer as practicable. A salt solution reservoir shall be located inside the exposure chamber and shall be adequately covered to prevent condensed fog from returning to the reservoir. The reservoir should hold at least a 72-hour supply of salt solution

The air temperature in the chamber shall be controlled between 92° and 97°F by heating the wall and floor surfaces. This can be obtained by water jacketing, or, the chamber may be placed in a room with the room temperature controlled to maintain a chamber temperature within the previously specified limits.

Salt spray (fog) shall be produced by blowing humidified air through an atomizer or nozzle to produce a stream of fine particles. The nozzle shall be so located or baffled as to prevent direct impingement on the test specimens.

Compressed air used for the fog nozzles shall be reasonably free from dust, oil, or excessive liquid - water particles and any foreign gases. The air shall contain sufficient water vapor to be in equilibrium with the atmosphere in the chamber which has an 84% relative humidity at a temperature of 95°F. It may be preconditioned by passing through a saturator. The size of the air bubbles and the water temperature are the most important controlling factors to condition the air properly. This or any other system may be used provided the compressed air has a relative humidity of 84 to 90% at a temperature of 95°F when released inside the chamber. The compressed air should be saturated with water vapor according to the following table:

Air Pressure p.s.i ----- 12 14 16 18

Water Temperature °F----- 110 112 115 117

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A thermometer shall be provided which will indicate or record the air temperature inside the chamber while in operation. Provisions shall be made to read the temperature without opening the chamber.

b. Salt Solution

The salt solution shall be prepared by dissolving 20 ± 2 parts by weight of salt in 80 parts by weight of distilled water or water containing not more than 200 parts per million of total solids. The salt used shall be sodium chloride containing on the dry basis not more than 0.1 percent of sodium iodide and not more than 0.2 percent of total impurities. The P^H of the solution shall be maintained at 6.5 to 7.2. The P^H measurement shall be made electrometrically using a glass electrode with a saturated potassium chloride bridge; or colorimetrically, provided the results obtained compare with the electrometric method. The concentration of the solution in the reservoir shall be maintained within the limits set forth above. In addition, before the solution is atomized, it shall be freed from suspended solids.

The sodium chloride concentration shall be collected by using at least two clean fog collectors placed within the exposure zone so that no drops of solution from the test item or any other source are collected. The collectors shall be placed in the proximity of the test item(s), one nearest to any nozzle and the other farthest from all nozzles. The fog shall be such that for each 80 sq. cm. of horizontal collecting area there will be collected in each collector from 0.5 to 0.3 cc of solution per hour based on the average of a run of at least 16 hours.

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APPENDIX D

UNIVERSAL TESTER

The Universal Tester has the capability of providing a direct readout of tension breaking strength, compression, and bursting strength of plastics, flexible food packaging, paper, and paper products, and other materials.

Its accuracy is better than plus 0.5 percent. It is programmable for either extension or compression. It has an extremely high response time. The tester ranges are from 0 to 10,000 pounds compression or tension. Cross-head speeds are from 0.002 to 20 inches per minute. The tester has been modified to include a reversible load design.

Accessory equipment provided for the Instron Tester includes jaws, jaw faces, jigs, fixtures, load weighing accessories, and chart control accessories. Other miscellaneous equipment provided includes an Automatic Integrator; Marker Pip Control; Preset Cycle Counter; and a Ball Burst and Spike Penetrating Fixture.